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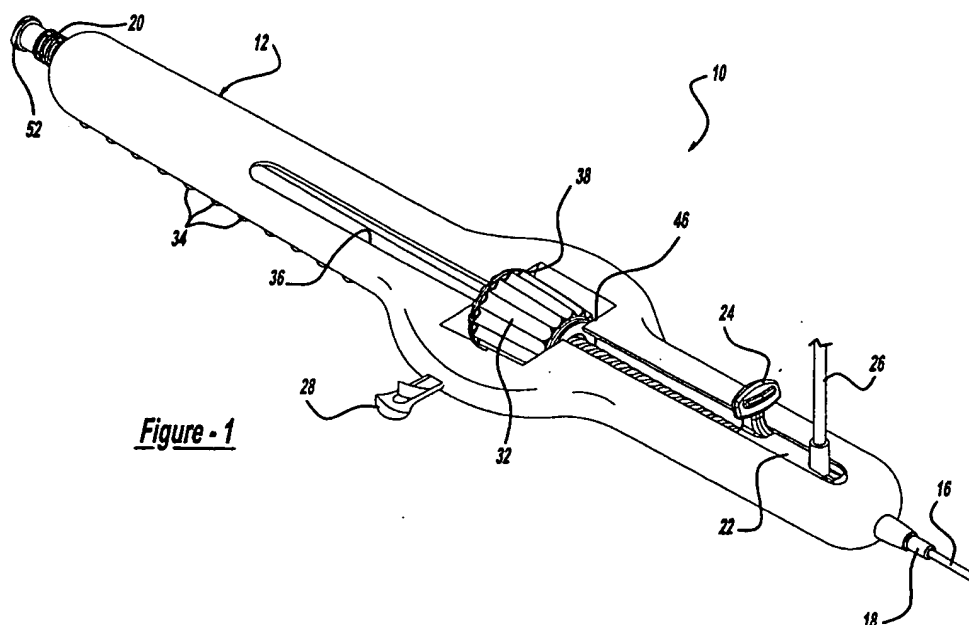
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(54) **Locking handle deployment mechanism for medical device**

(57) A medical device delivery system for therapeutically treating a patient, comprises an inner shaft, having proximal and distal ends and a tubular outer sheath, of which at least a portion surrounds a portion of the inner shaft member. A medical device is provided within the outer sheath in an initial configuration. A handle is operatively coupled with the inner shaft and the outer sheath, the handle having a first and second actuator for adjusting the relative positions of the inner shaft and

the outer sheath, each of the first and second actuators providing a different amount of mechanical advantage between an input to one of the first and second actuators by a physician and a resulting relative position of the inner shaft and the outer sheath respectively. A locking member releasably holds the outer sheath relative to the inner shaft in an initial configuration, so as to hold the outer sheath in the initial configuration and tending to resist inadvertently uncovering the medical device.



**Figure - 1**

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## Description

[0001] The present invention relates generally to medical devices, and more particularly to a medical device delivery system with an improved locking handle having a compound mechanism.

[0002] The present invention involves medical devices, and also the delivery systems used to convey them to a desired location for treatment, and then deploy them in position. Many such medical devices are resiliently compressed to a smaller initial size for containment, protection, storage and eventual delivery from inside a catheter system. Upon deployment, the medical devices may resiliently expand to a larger deployed size.

[0003] A successful example of a delivery catheter system, in this case for a self-expanding stent, is disclosed in US-6019778. The document discloses a flexible catheter system shown in a representative diagrammatic form in Figure 10, including coaxially arranged inner and outer catheter members, each having a hub affixed to its proximal end. The outer sheath is described as an elongated tubular member having distal and proximal ends, which is made from an outer polymeric layer, an inner polymeric layer, and a braided reinforcing layer between them. The inner shaft is described as being located coaxially within the outer sheath and has a flexible tapering distal end, which generally extends distally beyond the distal end of the outer sheath. The inner shaft member also is shown as including a stop which is positioned proximal from the distal end of the outer sheath. A self-expanding stent is located within the outer sheath, and is located between the stop on the inner shaft member and the outer sheath distal end. To deploy the stent the outer sheath is withdrawn by a physician in a proximal direction, while the inner shaft member is held in position.

[0004] Additional examples of different types of known self-expanding stent delivery systems are shown in US-4580568 and US-4732152.

[0005] In operation, these known medical device delivery systems are generally advanced within a body of a patient along a desired vascular path or other body passageway, until the medical device within the catheter system is located at a desired site for treatment. While watching the relative positions of the medical device and the catheter system components with respect to a stenosis on a video x-ray fluoroscopy screen, the physician holds the proximal hub attached to the inner shaft member in a fixed position with one hand, while simultaneously gently withdrawing the proximal hub attached to the outer tubular sheath with the other hand.

[0006] For several reasons, this deployment operation may require some measure of delicate skill. For example, among these reasons is the dynamic blood flow at the desired site for treatment, which may be further disrupted by the presence of a lesion or stenosis to be treated. Another factor is the gradual resilient expansion of a medical device as the outer sheath is retracted. This

gradual expansion presents an opportunity for a possible reverse "watermelon-seed" phenomenon to occur. This reverse watermelon-seed effect may cause the resilient medical device to tend to push the outer sheath back in a proximal direction with a force that tends to change as the sheath is progressively retracted.

[0007] As a result, the physician may need to accurately hold the two proximal hubs in a specific relative position, holding them against this expansion force, while attempting to very accurately position the medical device up until contact with the anatomy. One of the possibilities that may affect the positioning of the deployed medical device is that the inner shaft should preferably be held stationary in the desired position. If the physician's hand that holds the inner shaft hub does inadvertently move during deployment, it is possible that the medical device may be deployed in a non-optimum position.

[0008] Another possible factor is that the inner and outer catheter shaft members, like any other elongated object, do not have infinite column strength, which may present an opportunity for the position and movement of each proximal hub to differ from the position and movement of the respective distal ends of the inner and outer shaft members. Yet another factor is that the position of the medical device may be adjusted up until the point at which a portion of the expanding portion of the medical device touches the sidewalls of the body passage, so that the position of the medical device should preferably be carefully adjusted until immediately before a portion of the medical device touches the anatomy.

[0009] Some known catheter systems require two-handed operation, such as those with a pair of independent hubs, one hub on the inner and outer shaft member, respectively. Other known catheter systems include a pistol and trigger grip, with a single mode of deployment, involving a single trigger pull to deploy the associated medical device.

[0010] Accordingly, although physicians may be capable of operating such known systems with great skill, it is desirable to provide an improved catheter delivery system capable of facilitating easier and more accurate deployment and positioning of resiliently expansive medical device.

[0011] In addition, it is desirable to provide an advanced catheter deployment mechanism having two modes of operation. In the first mode of operation, the delivery mechanism preferably provides a precisely adjustable link between the inner and outer catheter shaft members, such that the relative position of the outer sheath with respect to the inner catheter shaft member can be precisely and selectively adjusted. Yet at any selected position, the delivery mechanism should preferably maintain this selected relative position of the inner and outer catheter shaft members, while resisting any force that may be present tending to move the inner or the outer catheter shaft members with respect to the other. In a second mode of operation, the delivery mecha-

nism should preferably enable the physician to rapidly withdraw the outer tubular sheath with respect to the inner catheter shaft member preferably in a proximal direction with a single easy motion.

**[0012]** Moreover, it is desirable to provide an integrated and ergonomic handle for easily and effectively operating the stent delivery system of the present invention.

**[0013]** It is also desirable to provide a handle for operating a stent delivery system that includes a locking mechanism. Such a locking mechanism preferably resists inadvertent or accidental movement or retraction of the stent delivery system components during packaging, sterilization, shipping, storage, handling and preparation. The lock preferably is spring-loaded, or otherwise easily released.

**[0014]** In one aspect the invention provides a medical device delivery system for therapeutically treating a patient, comprising:

an inner shaft, having proximal and distal ends;  
a tubular outer sheath, at least a portion of which surrounds a portion of the inner shaft member;  
a medical device within the outer sheath in an initial configuration;  
a handle operatively coupled with the inner shaft and the outer sheath;  
the handle having a first and second actuator for adjusting the relative positions of the inner shaft and the outer sheath, each of the first and second actuators providing a different amount of mechanical advantage between an input to one of the first and second actuators by a physician and a resulting relative position of the inner shaft and the outer sheath respectively; and  
a locking member that releasably holds the outer sheath relative to the inner shaft in an initial configuration, thereby holding the outer sheath in the initial configuration and tending to resist inadvertently uncovering the medical device.

**[0015]** In another aspect, the invention provides a handle for manipulating a medical device delivery system for therapeutically treating a patient, comprising:

a housing;  
first and second shaft members;  
the first shaft member being affixed to the housing;  
the second shaft member being movably coupled to the first shaft member, such that the second shaft member can be moved longitudinally with respect to the first shaft member;  
first and second means for selectively moving the second shaft member with respect to the first shaft member;  
the first means being adapted for precise and sensitive adjustment of the position of the second shaft member, and the second means being adapted for

rapid and relatively large-scale movement of the second shaft member; and  
a locking member that releasably holds the first and second shafts in a constant initial relative position.

**[0016]** In a further aspect, the invention provides a handle for manipulating a stent delivery system to therapeutically treat a patient, comprising:

a housing having a slot and a drive shoulder;  
inner and outer shaft members; the inner shaft member being affixed to the housing;  
at least a portion of the outer shaft member surrounding a portion of the inner shaft member, such that the outer shaft member can be moved longitudinally with respect to the inner shaft member;  
a hub assembly affixed to a proximal end of the outer shaft member and being longitudinally movable within the housing; the hub assembly having a grasping knob and a threaded drive member; the grasping knob extending outward through the housing slot;

wherein the hub assembly may be directly moved in a longitudinal direction relative to the inner shaft member by pulling on the grasping knob;

a rotatable actuator having a bearing surface and being mounted about the threaded drive member in threaded engagement; such that rotation of the actuator in a selected direction about the threaded drive member causes the rotatable actuator to press on the bearing surface, thereby pulling in a proximal direction the threaded drive member, hub and outer shaft member;

whereby the position of the outer shaft member relative to the inner shaft member may be adjusted by the rotatable actuator in a precise and sensitive manner, while movement of the grasping knob causes rapid and relatively large-scale movement of the outer shaft member relative to the inner shaft member; and

a locking member that releasably holds the inner and outer shafts in a constant initial relative position.

**[0017]** The handle mechanism may also provide for activation and retraction of the sheath only, while resisting an attempt to re-advance the sheath and re-cover the medical device.

**[0018]** Another embodiment of the present invention involves providing a single actuator for both or all of the multiple modes of operating the handle and delivery system.

**[0019]** Additional embodiments of the present invention relate to different types of movement to actuate each mode of operation. For example, a single actuator may rotate for a first mode of operation, and slide in an-

other mode. Or a single actuator may rotate in one direction for a first mechanical advantage, and rotate in another direction for a different mechanical advantage.

[0020] The present invention accordingly provides such a desirable medical device delivery mechanism, with an integrated and ergonomic handle replacing the functions of the separate proximal hubs of the prior inner and outer catheter shaft members, providing desired dual modes of operation as well as the desired locking system.

[0021] Among the possible medical device delivery systems that may be used with the present invention is any appropriate system in which an outer sheath is provided, surrounding an inner shaft. A medical device may be carried within the outer sheath during delivery to a desired site for treatment, where the outer sheath may be retracted, while the inner shaft and medical device are held in place.

[0022] The present invention may also be embodied in medical device delivery systems in which the motion of the operator to deploy the medical device is selected from any suitable possibility, including axial motion in the proximal direction or distal direction, or a rotational motion, a trigger actuator, a gear mechanism, or any other type of actuator that may be preferred, depending upon a particular application. Indeed, the present unique concept may be used for medical device delivery systems in which the medical device is deployed in any suitable manner, including retracting an outer sheath in a proximal or distal direction, or uncovering a medical device in various ways, including withdrawing portions of outer sheath members in proximal and distal directions; simultaneously or sequentially.

[0023] The present invention may preferably have several advantages individually, or any combination of such advantages, including for example: (i) single-handed operation of the medical device delivery system; (ii) a mechanism providing leverage or mechanical advantage, to adjust or reduce the forces needed to operate the system; (iii) improved accuracy in positioning the medical device during deployment; and (iv) multiple operational modes of operation, including for example a first mode of fine and precise control of the deployment process, and a second mode of rapid and easy deployment.

[0024] Moreover, additional advantages may include: (i) an integrated and ergonomic handle for easily and effectively operating the stent delivery system of the present invention; (ii) a locking mechanism capable of resisting inadvertent or accidental movement or retraction of the stent delivery system components during packaging, sterilization, shipping, storage, handling and preparation; and (iii) a capability of holding the delivery system components in a fixed relative position during an intermediate point in deploying a medical device.

[0025] Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is an external perspective view of a medical device delivery system handle, arranged according to the principles of the present invention;

Figure 2 is a partial longitudinal cross-sectional view of a medical device delivery system arranged according to the present invention in an initial configuration;

Figure 3 is a partial side elevation view of the medical device delivery system of Figure 2;

Figure 4 is a partial top plan cross-sectional view of the medical device delivery system of Figure 2;

Figure 5 is a partial longitudinal cross-sectional view of certain components of a medical device delivery system according to the present invention;

Figure 6 is a perspective view of certain components of a medical device delivery system according to the present invention;

Figures 7-10 are partial longitudinal cross-sectional views of certain components of a medical device delivery system according to the present invention; and

Figures 11-14 are perspective views of proximal and distal ends of a medical device delivery system arranged according to the principles of the present invention, in various operating configurations.

[0026] Referring to the drawings, a medical device delivery system includes a handle 10, shown in detail in Figures 1-10. An upper and lower main body housing 12 and 14 are arranged in a top-and-bottom configuration, as shown for example in Figures 1 and 3. Other components include inner and outer shaft members 16 and 18 respectively, an anchoring member 20, a proximal hub 22 with an actuator or knob 24 and a corresponding flush lumen tube 26, as well as a threaded base member 30 and a rotating finger ring 32.

[0027] In addition, the handle of the present invention preferably has a locking mechanism 28 for releasably locking the outer shaft member 18 in an initial position relative to the handle 10 and the inner shaft member 16, by resisting movement of the rotating finger ring 32 relative to the upper and lower body housings 12 and 14, and thus preventing motion of the threaded base 30 and proximal hub 22.

[0028] The lower main body housing 14 preferably has several gripping knurls 34 for providing a physician with a good gripping surface, while the upper main body housing 12 has a longitudinal slot 36 defining a channel for sliding the movable actuator 24 and thus limiting the extent of possible travel for the actuator 24 and proximal hub assembly 22. Together, the upper and lower body housings 12 and 14 define openings 38 through which a physician can operate the rotating finger ring 32, a proximal anchoring aperture 40 adapted to capture a portion of the anchoring member 20, a distal shaft aperture 42 through which the inner and outer shaft members 16 and 18 extend, and several internal openings for receiving fasteners 44 to hold the main body hous-

ings 12 and 14 together. They also define a circular annular bearing shelf or shoulder 46.

[0029] In the preferred initial configuration, proximal hub 22 is affixed to threaded base 30, which rotatably carries rotating finger ring 32. A distal surface of rotating finger ring 32 touches and bears on shoulder 46 of main body housing 12. Rotation of the rotating finger ring 32 causes it to press on shoulder 46 and pull on threaded base 30, resulting in very precise and sensitive withdrawing movement of outer shaft member 18 in a proximal direction. Then, when more rapid proximal withdrawal of the outer shaft member 18 is desired, the physician may grasp the actuator 24 and swiftly draw the hub 22 directly back in the proximal direction.

[0030] In the particular assembly shown in the drawings, main body housings 12 and 14 are held together by fasteners 44. Anchor aperture 40 fixedly receives anchor 20, which is affixed to the proximal end of inner shaft member 16. A proximal end of outer shaft member 18 is affixed to proximal hub 22, with a flexible strain relief 48 protecting the joint.

[0031] An example of operating the medical device delivery system of the present invention is graphically depicted in Figures 11-14, which include illustrations of a handle 54 having a different appearance than handle 10 shown in Figures 1-10. In operation, the distal end 56 of the medical device delivery system is preferably directed into a patient via a body passageway. The medical device delivery system may preferably follow along a guidewire (not shown), and/or travel through a previously placed guiding catheter (not shown), until the distal end 56 is at a desired location for treatment. As shown in Figure 11, the distal tip 56 has preferably crossed the site of a lesion or stenosis 58. When the device is properly in an initial position, the physician releases or breaks off the lock of the present invention. A single embodiment of the lock is illustrated in Figures 1 and 4, and of course the present invention encompasses a multitude of various lock configurations, including pins, clamps, breakable members, spring-loaded locks, splines, or keys. The lock may be releasable only once, or may be capable of repeatedly being engaged and released. For example, the lock shown in Figures 1-10 may be initially released by squeezing the components, and then used to re-lock the system in another position or configuration, such as for example that shown in Figure 13.

[0032] Such a locking mechanism preferably resists inadvertent or accidental movement or retraction of the stent delivery system components during packaging, sterilization, shipping, storage, handling and preparation.

[0033] After the lock is released, the preferred operation of the present invention may be accomplished by first rotating the finger ring 60 to cause it to advance on threaded base 62 and press against shoulder 64, such that the entire assembly of threaded base 62, proximal hub and outer shaft member 66 withdraw proximally with

respect to handle 54, and thus with respect to inner shaft member 68. This first method of withdrawing the outer sheath 66 allows precise and sensitive adjustment.

[0034] As shown in Figures 11 and 12, the physician may rotate the finger ring 60 slightly, to pull the outer sheath 66 back slightly. This small movement exposes a small portion of the medical device, in this case a stent 50, as shown in Figure 12. In this configuration, the handle of the present invention will hold the outer sheath 66 in position relative to the inner body 68, resisting further inadvertent expansion of the stent 50. The physician then has the time and flexibility of procedure to selectively optimize and make any final adjustments to the position of the medical device and delivery system within the desired site, as illustrated by the arrow in Figure 12. This precise adjustment of the position of the stent 50, before any portion of the stent 50 touches the body passage or vessel 70 in a manner that might inhibit further positional adjustment, is preferable.

[0035] When the physician is satisfied with the positioning, as it appears on a fluoroscopic x-ray video screen, the physician may continue to rotate the finger ring 60 to further withdraw the outer sheath 66, as shown in Figure 13.

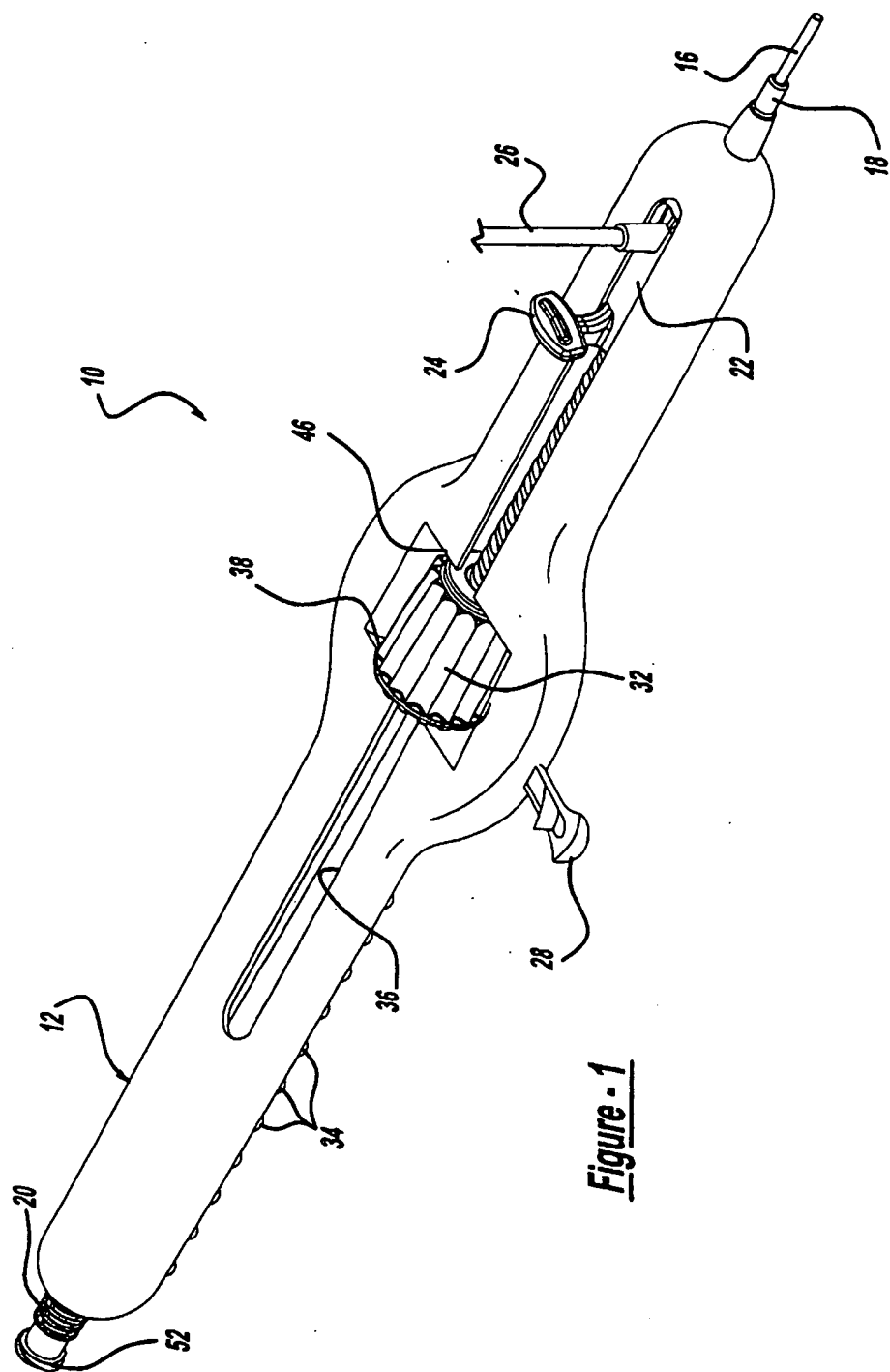
[0036] Upon initial contact of the stent 50 with the vessel wall, or when the stent is expanded sufficiently to independently hold its position, or at any desired point, the physician may simply grasp knob 72 and pull or push it along slot 74, as depicted by the arrow in Figure 14. This second method of withdrawing the outer sheath 66 allows relatively large-scale and rapid movement, at whatever speed the physician wishes, to quickly deploy the medical device.

[0037] Various materials may be selected for the components of the present invention, including any material having the desirable performance characteristics. In the particular embodiment shown in the drawings, the inner and outer shaft members 16 and 18, strain relief 48, and distal tip 56 may be made of any biocompatible and suitably flexible yet sufficiently strong material, including polymers of various types. Possible selections for such materials include nylons or polyamides, polyimides, polyethylenes, polyurethanes, polyethers, polyesters, etc. In the alternative, some portion or all of the inner and/or outer shaft member 16, 18 may be formed of a flexible metal, including for example stainless steel or a shape memory alloy (such as a nickel titanium based alloy referred to as nitinol) hypotube. The stent 50 is preferably made of any biocompatible material that is strong and rigid, including for example stainless steel, platinum, tungsten, etc. The components of the handle of the present invention are preferably made of a material that is strong and rigid, including for example inflexible polycarbonates, or even some metal components.

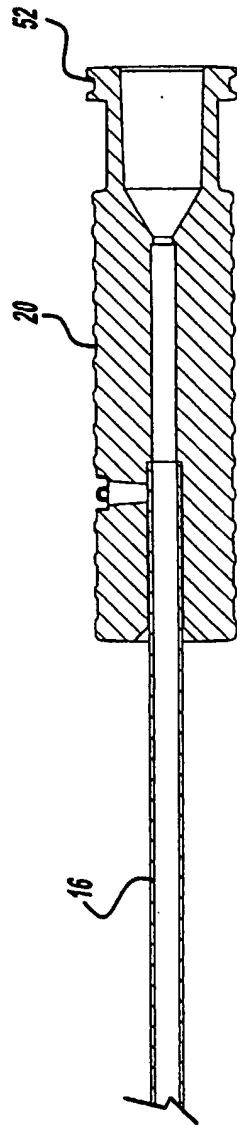
[0038] The inner shaft member 16 assembly, including anchor 20, inner shaft member 16 and distal tip 56, may preferably be provided with a through lumen adapted to receive a guidewire.

**Claims**

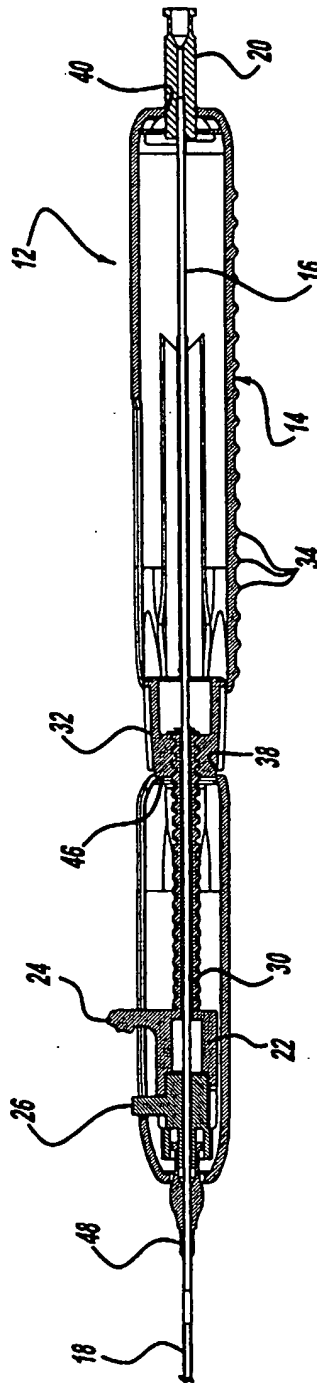
1. A medical device delivery system for therapeutically treating a patient, comprising:
  - an inner shaft, having proximal and distal ends; a tubular outer sheath, at least a portion of which surrounds a portion of the inner shaft member;
  - a medical device within the outer sheath in an initial configuration;
  - a handle operatively coupled with the inner shaft and the outer sheath;
  - the handle having a first and second actuator for adjusting the relative positions of the inner shaft and the outer sheath, each of the first and second actuators providing a different amount of mechanical advantage between an input to one of the first and second actuators by a physician and a resulting relative position of the inner shaft and the outer sheath respectively; and
  - a locking member that releasably holds the outer sheath relative to the inner shaft in an initial configuration, thereby holding the outer sheath in the initial configuration and tending to resist inadvertently uncovering the medical device.
2. The medical device delivery system of claim 1, wherein the locking member has first and second surfaces, such that in the initial configuration the first surface releasably holds a component attached to the outer sheath, and the second surface releasably holds a portion of the handle.
3. The medical device delivery system of claim 1, wherein the locking member has one or more flanges that releasably resist movement of one or more of the first and second actuators.
4. The medical device delivery system of claim 1, wherein the first actuator provides a mechanical advantage of 1:1.
5. The medical device delivery system of claim 1, wherein the first actuator is adapted to slide along a longitudinal slot defined by the handle.
6. The medical device delivery system of claim 1, wherein the second actuator provides a mechanical advantage greater than 1:1, to facilitate an operator to overcome initial resistance to changing the initial relative position of the inner shaft and the outer sheath.
7. The medical device delivery system of claim 1, wherein the second actuator is adapted to rotate around a threaded base.
8. The medical device delivery system of claim 1, wherein the second actuator provides a variable mechanical advantage that can be selected by an operator from among a pre-selected range of possible mechanical advantages.
9. The medical device delivery system of claim 1, wherein one of the first and second actuators is formed as a lever.
10. The medical device delivery system of claim 1, further comprising a guidewire lumen for slidably receiving a flexible guidewire.
11. The medical device delivery system of claim 1, wherein the medical device is a stent of the self-expanding type.
12. The medical device delivery system of claim 11, wherein the stent is of the self-expanding type.
13. The medical device delivery system of claim 1, further comprising a unified actuator knob, wherein the first actuator is a slider coupled to the outer shaft adapted to slide with respect to the handle, wherein the second actuator is a threaded coupling between the knob and the slider; such that the unified actuator knob is adapted to operate both the first and second actuators.



**Figure - 1**



**Figure - 5**



**Figure - 2**



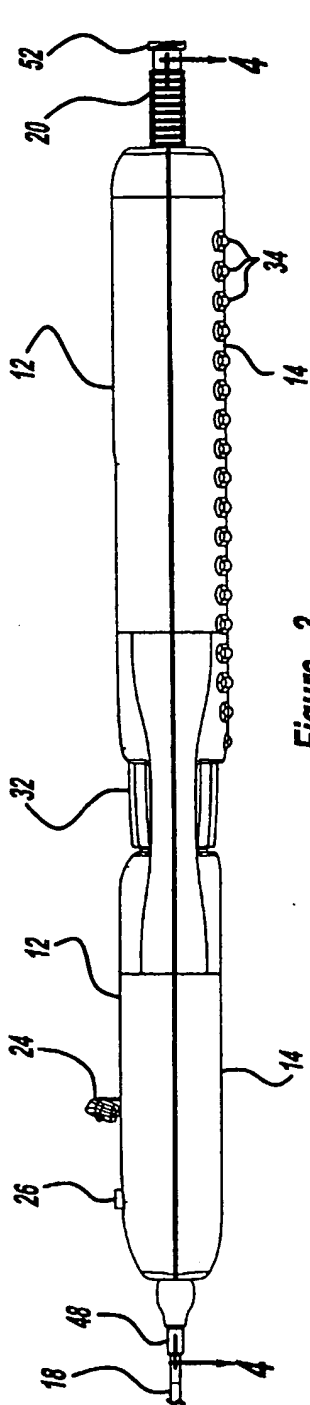


Figure - 3

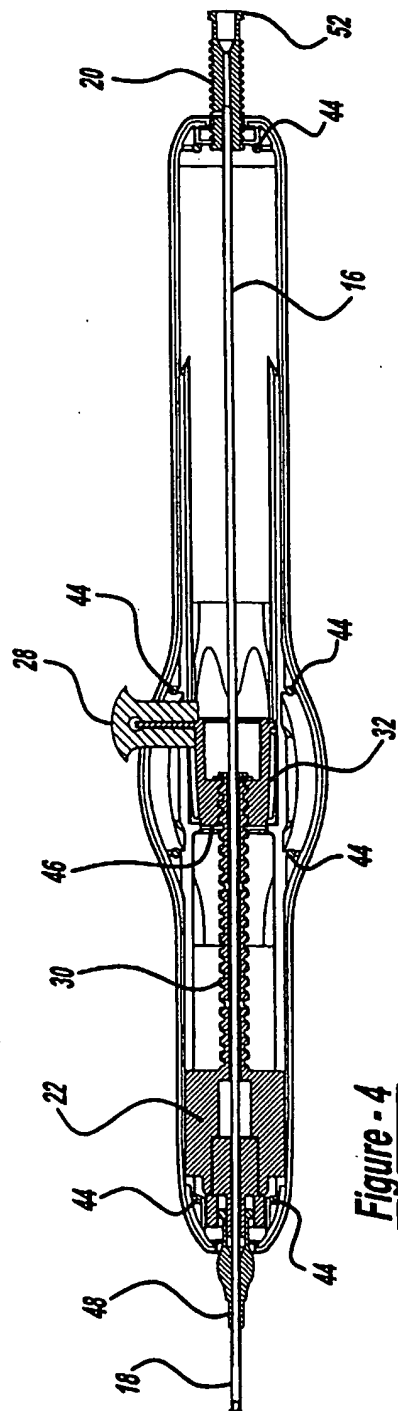
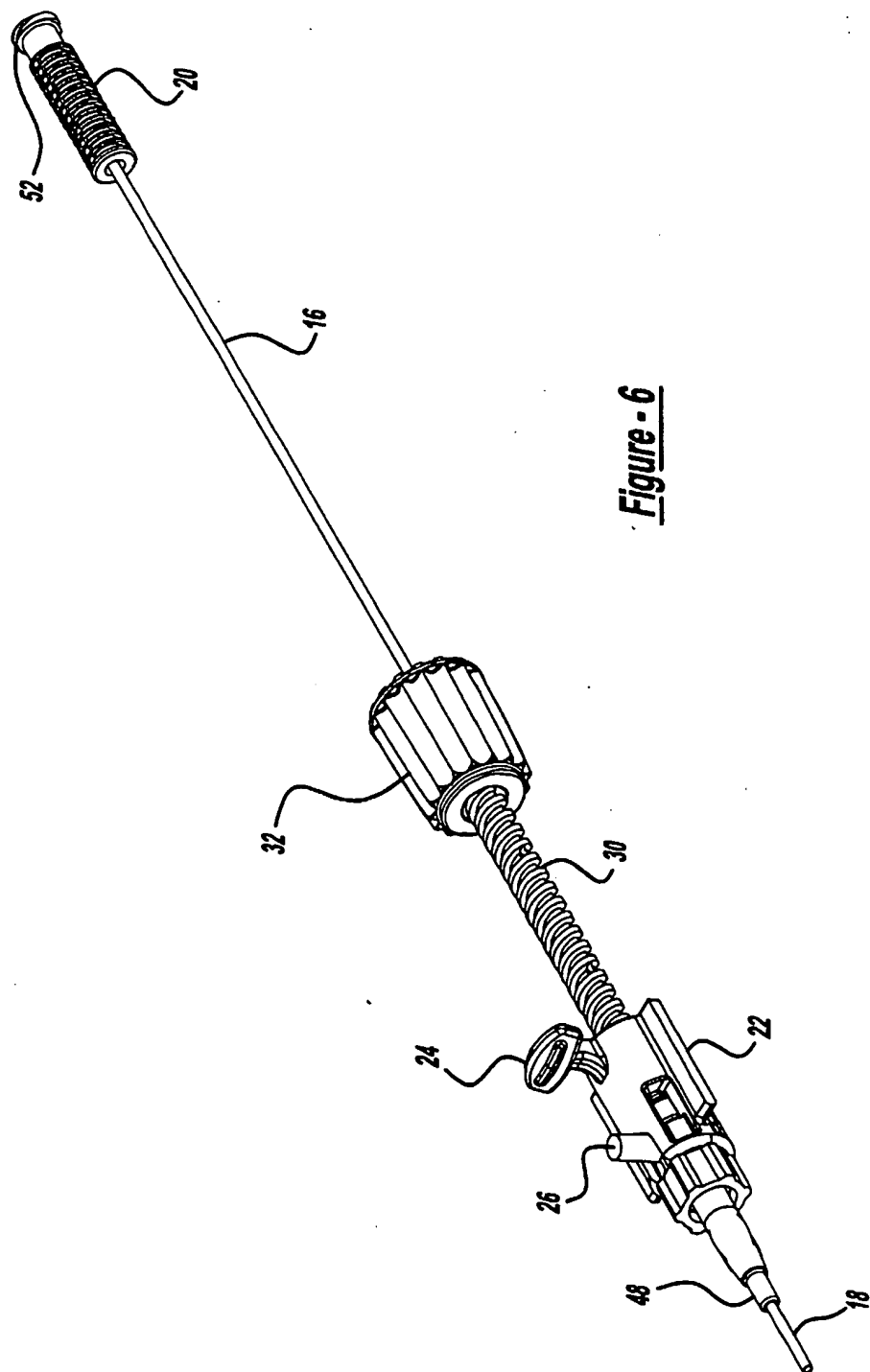


Figure - 4



**Figure - 6**

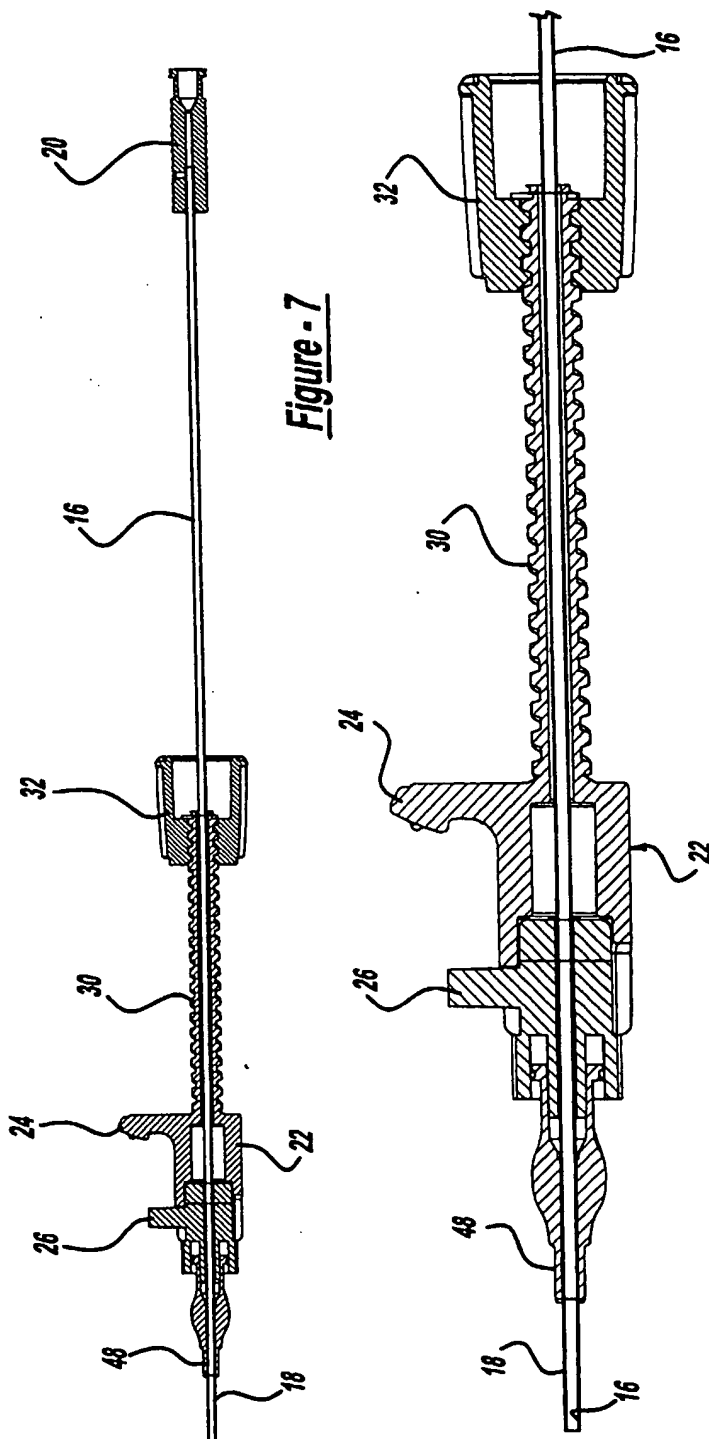
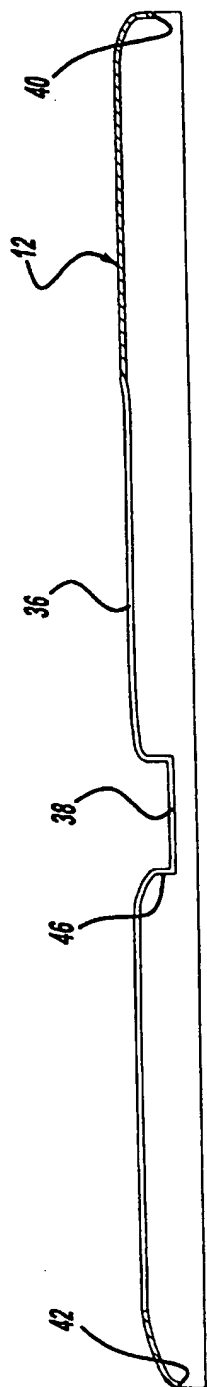
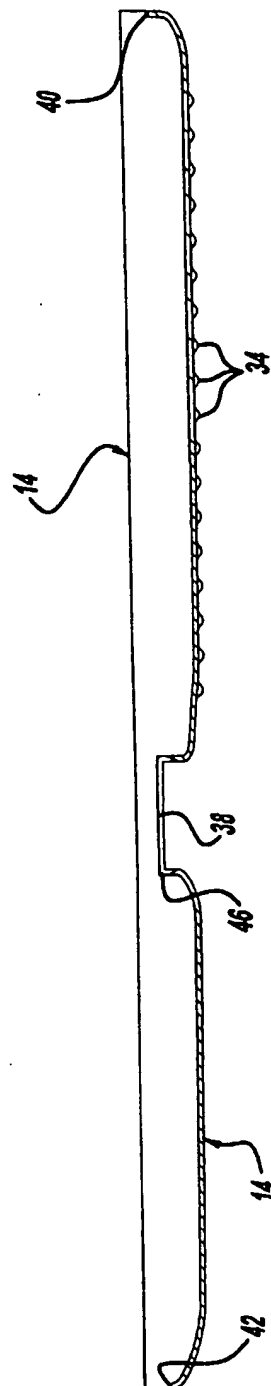


Figure - 7

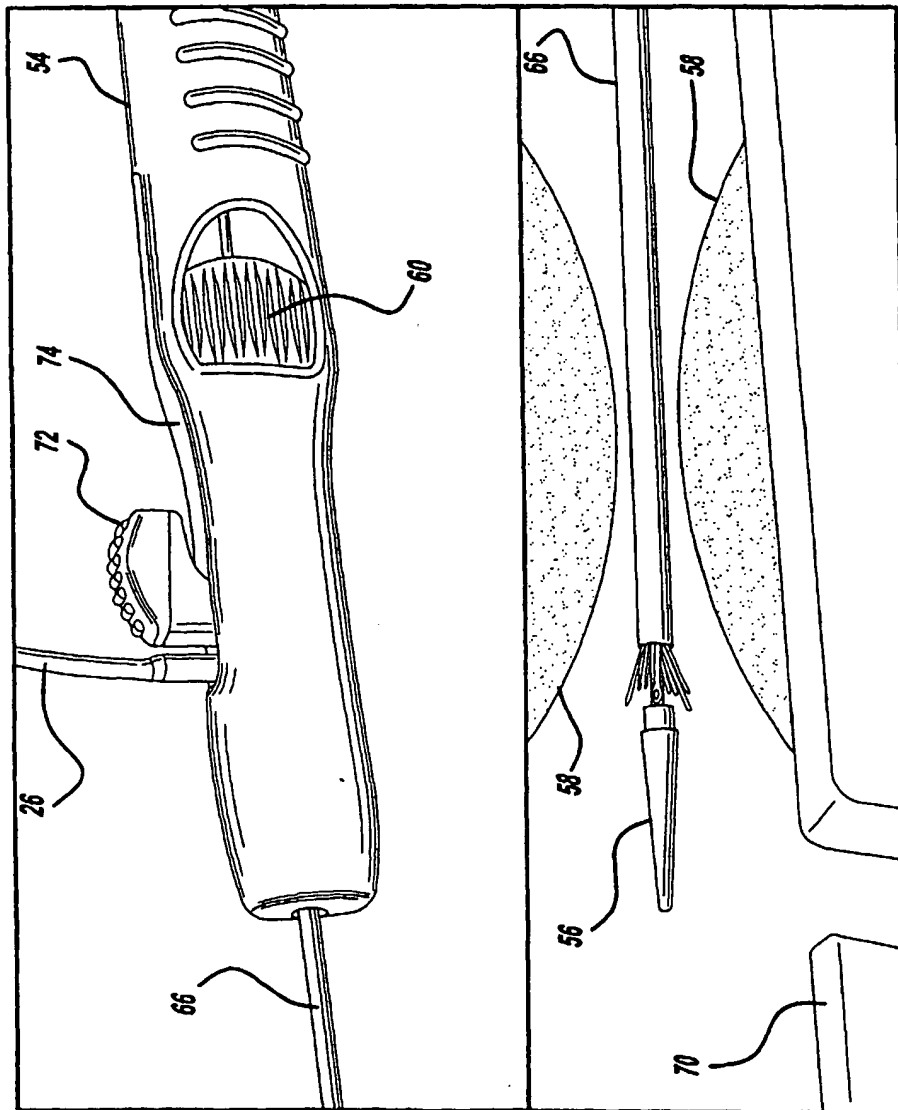
Figure - 8



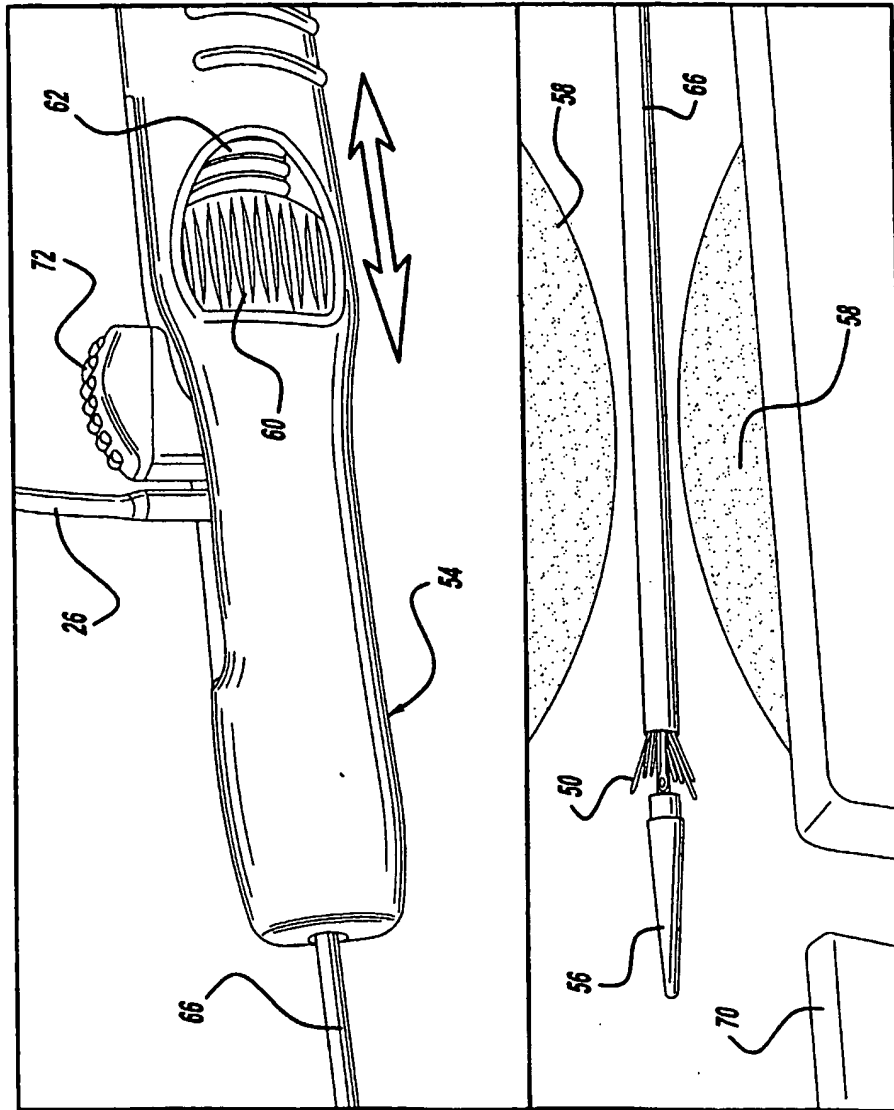
**Figure - 9**



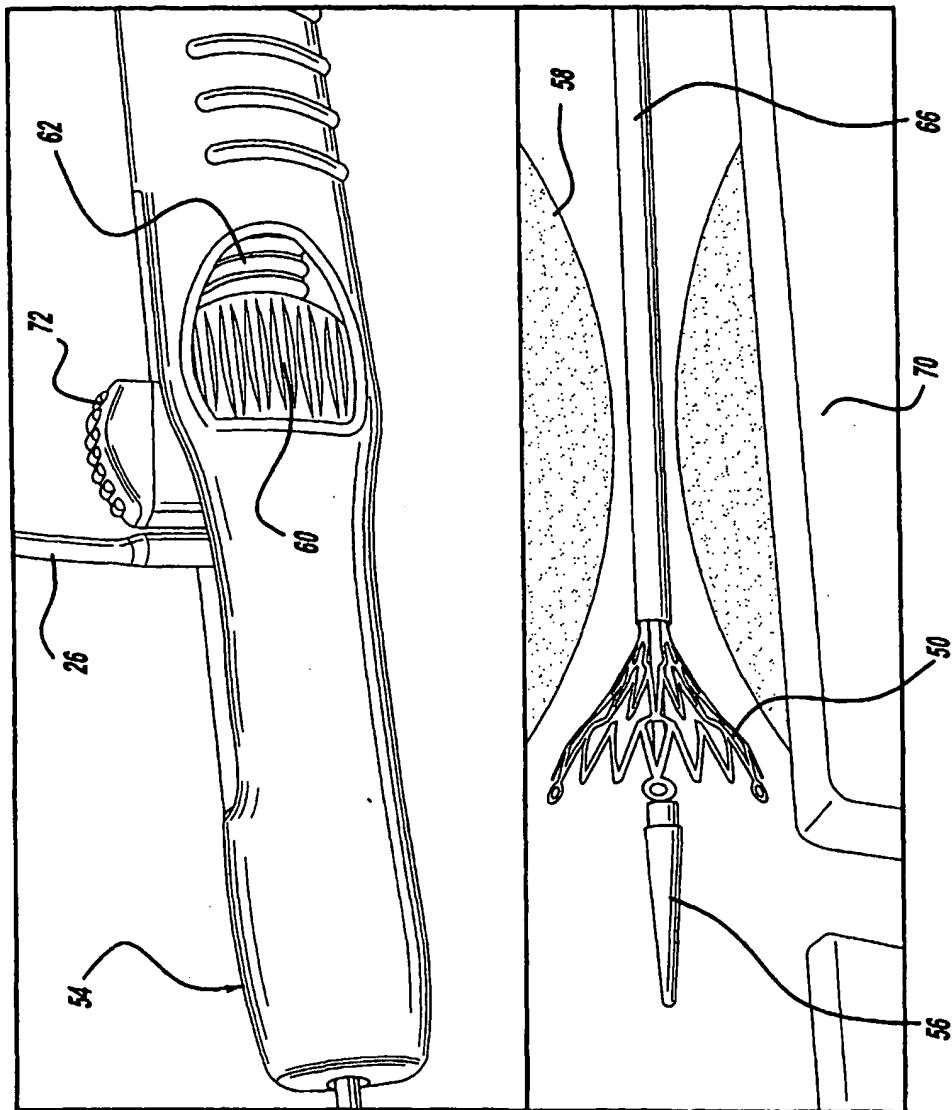
**Figure - 10**



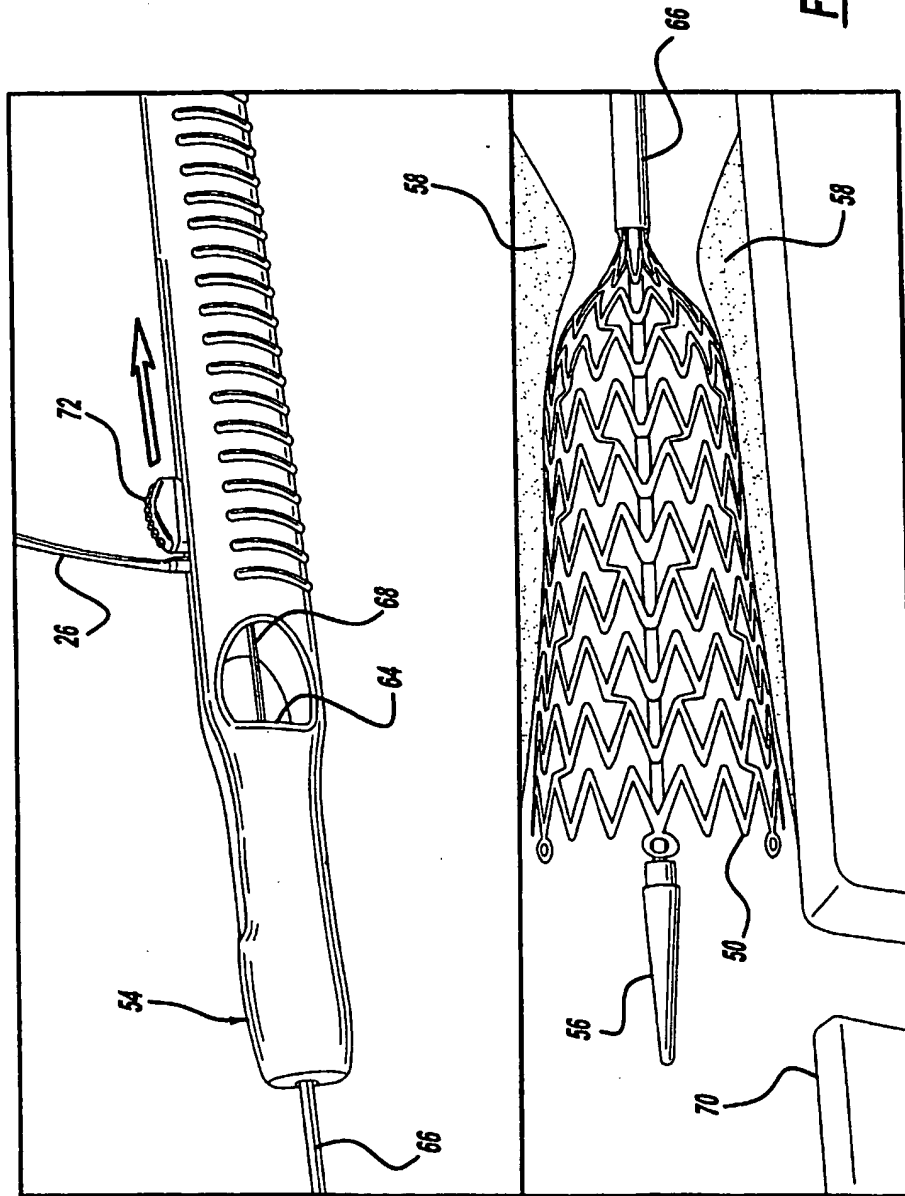
**Figure - 11**



**Figure - 12**



**Figure - 13**



**Figure - 14**





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## EUROPEAN SEARCH REPORT

Application Number  
EP 03 25 3776

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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P,L, Y	EP 1 302 178 A (CORDIS CORP) 16 April 2003 (2003-04-16) * the whole document * ---	1	
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			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			A61F
The present search report has been drawn up for all claims			
Place of search <b>MUNICH</b>		Date of completion of the search <b>11 November 2003</b>	Examiner <b>Daintith, N</b>
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

EPO FORM 1503 03.02 (p04001)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 03 25 3776

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
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